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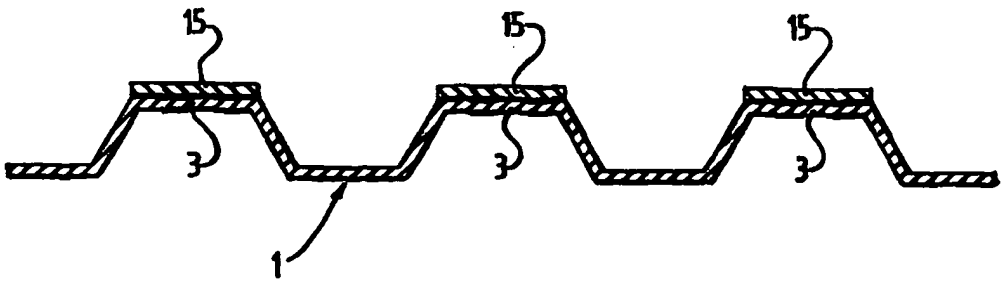

(57) Abstract

The invention relates to a wall element of sheet metal, comprising a general wave shape consisting of a succession of waves, each comprising substantially rectangular plate parts mutually connecting at chosen angles, wherein all connecting lines between adjacent parts are mutually parallel, wherein a first part is followed by a second part connecting thereto at an angle, the second part is followed by a third part connecting thereto at an angle, such that the first and the third part are mutually parallel, the third part is followed by a fourth part connecting thereto at an angle, the fourth part is followed by the first part of a subsequent wave, and so on, characterized in that at least a number of the first and/or third parts are strengthened by a plate adhered thereto at least in each associated middle zone.

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CORRUGATED WALL ELEMENT

The invention relates to a wall element of sheet metal, comprising a general wave shape consisting of a succession of waves, each comprising substantially rectangular plate parts mutually connecting at chosen angles, wherein all connecting lines between adjacent parts are mutually parallel,

wherein a first part is followed by a second part connecting thereto at an angle,

the second part is followed by a third part connecting thereto at an angle,

such that the first and the third part are mutually parallel,

the third part is followed by a fourth part connecting thereto at an angle,

the fourth part is followed by the first part of a subsequent wave, and so on.

Such a wall element is generally known and is designated as a sheet pile wall profile. The plate metal is generally steel and is generally provided with an anti-corrosive coating, for instance by galvanizing, enamelling, lacquering or combinations thereof.

Such wall elements are often used as part of a for instance thermally insulating wall, inter alia in applications where the danger of explosion exists. This is for instance the case in use in the extraction of mineral fuels such as crude oil, natural gas and the like.

A wall element of the described type is usually placed such that said connecting lines extend in vertical direction. The general wave shape can therefore be best seen by making a cross-section of the relevant wall element. The shape in question will be explained below with reference to the figures.

The upper and the lower zones of a wall element are for instance connected in sealing and tensively strong manner to a bearing construction by means of welding. In the case where an explosion occurs in an area which is also bounded by a wall element of the described type, the deformation of this wall element is found to manifest itself as a buckle in the middle of the wall element, while the parts of the wall element extending downward and upward from this buckle remained more or less straight. The buckle has the character of a plastic hinge.

It is an object of the invention to embody wall elements of the described type such that the pressure at which said plastic deformation or other type of plastic deformation occurs is considerably increased, such that this deformation cannot occur in the explosion conditions to be anticipated and the wall element is substantially only elastically deformed temporarily during an explosion.

It is a further object of the invention to provide a method with which already installed wall elements can be strengthened such that said plastic deformations are substantially prevented in the same manner as specified above.

With a view to the above stated objectives, the invention provides a wall element of the described type which has the feature that at least a number of the first and/or third parts are strengthened by a plate adhered thereto at least in each associated middle zone.

The invention further provides a method for strengthening a wall element of sheet metal comprising a general wave shape, consisting of a succession of waves, each comprising substantially rectangular plate parts mutually connecting at chosen angles, wherein all connecting lines between adjacent parts are mutually parallel,

wherein a first part is followed by a second part connecting thereto at an angle,

the second part is followed by a third part connecting thereto at an angle,

such that the first and the third part are mutually parallel,

the third part is followed by a fourth part connecting thereto at an angle,

the fourth part is followed by the first part of a subsequent wave, and so on. According to the invention this reinforcement takes place by strengthening at least a number of the first and/or third parts by adhering a plate thereto at least in each associated middle zone.

A specific embodiment has the special feature that the plate is adhered to the middle zone by glue or solder.

Adhesion can take place over at least substantially the whole surface of the plate. It must be understood that the adhesion is essential for the strengthening function of the plate since the relevant first or third plate part is thickened by this adhesion, whereby its bending stiffness essentially increases.

A specific embodiment has the special feature that the glue or solder is applied in longitudinal strips.

A preferred embodiment has the special feature that the plate is a metal plate. This plate can be of the same type as the wall element.

It is noted that in order to adhere the plate to the wall element particular pretreatments may be required in some conditions, for instance removal of an anti-corrosive coating, application of a primer or the like. After arranging of a plate an anti-corrosive coating or the like can, if desired, be applied over the obtained combination with a usual spraying or brushing process.

Another embodiment has the special feature that the plate is a sandwich panel.

A sandwich panel has the advantage of a very low weight in relation to the obtained strengthening, but can have the drawback of a somewhat higher price.

Yet another embodiment has the special feature that the plate is reinforced with fibres of high tensile strength, which extend in a direction with at least a considerable longitudinal component, which fibres can for instance consist of glass, boron, carbon, aramid, Dyneema (trade mark of the Dutch concern DSM). These fibres can also be arranged crosswise. What is important is that the fibres contribute essentially to the bending strength. In this respect they must in any case, for instance predominantly, be situated on the outside of the wall element relative to the explosion side.

A further strengthening can be obtained with an embodiment in which the plate comprises side parts which fit flatly on the adjoining second and third parts and are adhered thereto.

The invention will now be elucidated with reference to the annexed drawings. Herein:

figure 1 shows a horizontal cross-section through a wall element according to the prior art;

figure 2 shows a schematic vertical cross-section of the wall element according to figure 1, wherein the situation after an explosion is indicated with broken lines;

figure 3 shows a vertical cross-section through a wall element according to the invention in a first embodiment;

figure 4 shows a view corresponding with figure 3 of a variant;

figure 5 shows a horizontal cross-section as according to V-V in figure 4;

figure 6 is a horizontal cross-section through a detail during the arranging of a strengthening plate;

figure 7 shows a cross-section corresponding with figure 5 through a variant;

figure 8 is a cross-section corresponding with figure 5 through yet another embodiment;

figure 9 is a cross-section corresponding with figure 5 through a further development of the structure according to figure 8; and

figure 10 shows a cross-section corresponding with figure 5 through a further development of the structure of figure 8, wherein the strengthening plates are arranged on both sides.

Figure 1 shows a wall element 1 of plate metal comprising a general wave shape with a succession of waves 2, each having substantially rectangular parts mutually connecting at chosen angles, in this case equal angles, wherein all connecting lines between adjacent parts are mutually parallel. This means that each wall element has a prismatic form, which means that all cross-sections perpendicular to the associated connecting lines are the same.

A first part 3 is followed by a second part 4 which connects thereto at an angle and to which connects a third part 5 to which in turn a fourth part 6 connects. The parts 3, 4, 5 and 6 together form one wave. It is noted that the drawn choice is random. What is important however is to define a continuous wave.

Figure 2 shows wall element 1 in the situation where it is connected with its lower zone 7 and its upper zone 8 in sealing and tensively strong manner, for instance by welding, to respective structural parts 9 and 10. Shown very symbolically and schematically is that the wall element is subjected to an explosion, the shock front of which is indicated symbolically with arrows 11. As a result of this explosion the wall element 1 will deform plastically and after the explosion assume the shape shown with broken lines. In this situation the wall element is designated with 1'. Situated in the middle zone is a buckle 12 which mechanically behaves as a plastic hinge. The wall element parts connecting thereto are substantially straight.

The structure according to the invention to be described hereinbelow has for its object to substantially strengthen at least the middle zone in which buckle 12 has occurred.

Figure 3 shows that wall panel 1 is strengthened over its entire length by a metal plate 21, which is adhered fixedly to first part 3 by glueing or soldering. Wall panel 1 is further strengthened in middle zone 13 by a second metal plate 14 glued to said metal plate 21.

Figure 4 shows that a metal plate 15 can possess a greater length. It will be apparent that the strengthening plate can also extend over the whole height of first part 3.

Figure 5 shows the cross-section V-V according to figure 4. In this embodiment the strengthening plates 15 are adhered to the first plate parts 3 over the whole width thereof.

Figure 6 shows that the glue can extend in longitudinal strips 16. It will otherwise be apparent that when strengthening plate 16 is pressed toward first plate part 3 the glue will also displace laterally.

Figure 7 shows a variant of the embodiment according to figure 5. In this embodiment use is made of a sandwich panel 17 which is adhered to first plate part 3 with glue. Sandwich panel 17 comprises a first skin plate 18, a second skin plate 19 and a core present between these two skin plates and adhered to these skin plates over the whole of the relevant surfaces, consisting in known manner of for instance a foam material, a honeycomb structure or the like. To make the bending stiffness of the sandwich panel as great as possible, skin plate 19 in particular can be provided with a tensively strong reinforcement with fibres which extend in a direction with at least a considerable longitudinal component. In this respect reference is once again made to figure 2, from which it will be apparent that, when strain of pressure is applied as according to

arrows 11, particularly skin plate 19 is placed under strain of tension. Owing to the presence of fibres with tensile strength a deformation 1' as shown in figure 2 can to a large degree be prevented.

Figure 8 shows a variant in which a metal strengthening plate 20 comprises side parts 21, 22 which fit flatly on the adjoining second part 4 and fourth part 6 and are adhered thereto.

Figure 9 shows an embodiment in which a strengthening plate 23 is provided with comparatively long side parts 24, 25.

Finally, figure 10 shows a variant of figure 8. In this embodiment not only the first parts 3 but also the third parts 5 are strengthened with strengthening plates 20 of exactly the same type as strengthening plate 20 for part 3. These plates 20 comprise side parts 21, 22 which are adhered respectively to second part 4 and fourth part 6.

It is noted that in figure 8, figure 9 and figure 10 the glue strips 16 are drawn schematically. It will be apparent that these glue strips 16 are essentially pressed flat after the adhesion between strengthening plates and wall element has been effected.

CLAIMS

1. Wall element of sheet metal, comprising a general wave shape consisting of a succession of waves, each comprising substantially rectangular plate parts mutually connecting at chosen angles, wherein all connecting lines between adjacent parts are mutually parallel,

wherein a first part is followed by a second part connecting thereto at an angle,

the second part is followed by a third part connecting thereto at an angle,

such that the first and the third part are mutually parallel,

the third part is followed by a fourth part connecting thereto at an angle,

the fourth part is followed by the first part of a subsequent wave, and so on,

characterized in that

at least a number of the first and/or third parts are strengthened by a plate adhered thereto at least in each associated middle zone.

2. Wall element as claimed in claim 1, characterized in that the plate is adhered to the middle zone by glue or solder.

3. Wall element as claimed in claim 2, characterized in that the glue or solder is applied in longitudinal strips.

4. Wall element as claimed in claim 1, characterized in that the plate is a metal plate.

5. Wall element as claimed in claim 1, characterized in that the plate is a sandwich panel.

6. Wall element as claimed in claim 1, characterized in that the plate is reinforced with fibres of high tensile strength which extend in a direction with at least a considerable longitudinal component, which

fibres can for instance consist of glass, boron, carbon, aramid, Dyneema (trade mark of the Dutch concern DSM).

7. Wall element as claimed in claim 1, characterized in that the plate comprises side parts which fit flatly onto the adjoining second and third parts and are adhered thereto.

8. Method for strengthening a wall element of sheet metal comprising a general wave shape, consisting of a succession of waves, each comprising substantially rectangular plate parts mutually connecting at chosen angles, wherein all connecting lines between adjacent parts are mutually parallel,

wherein a first part is followed by a second part connecting thereto at an angle,

the second part is followed by a third part connecting thereto at an angle,

such that the first and the third part are mutually parallel,

the third part is followed by a fourth part connecting thereto at an angle,

the fourth part is followed by the first part of a subsequent wave, and so on,

according to which method at least a number of the first and/or third parts are strengthened by adhering a plate thereto at least in each associated middle zone.

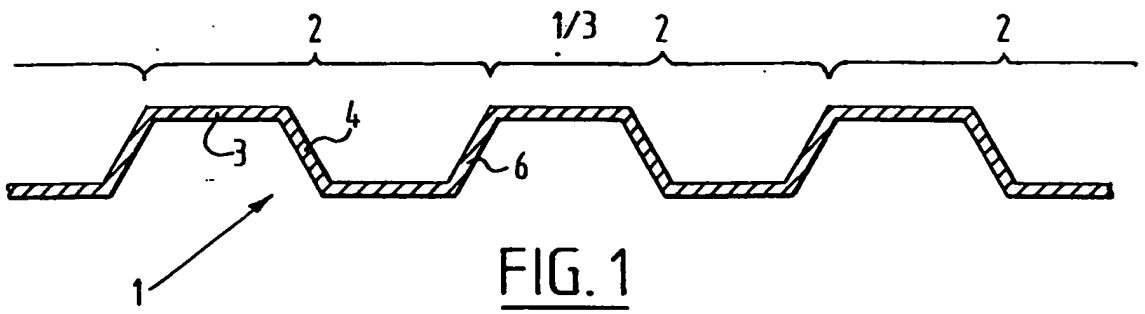

FIG. 1

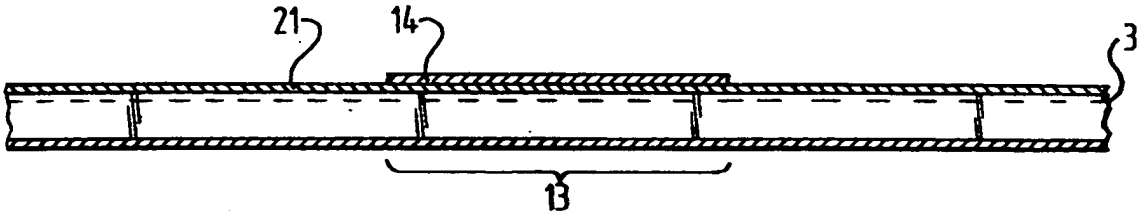

FIG. 3

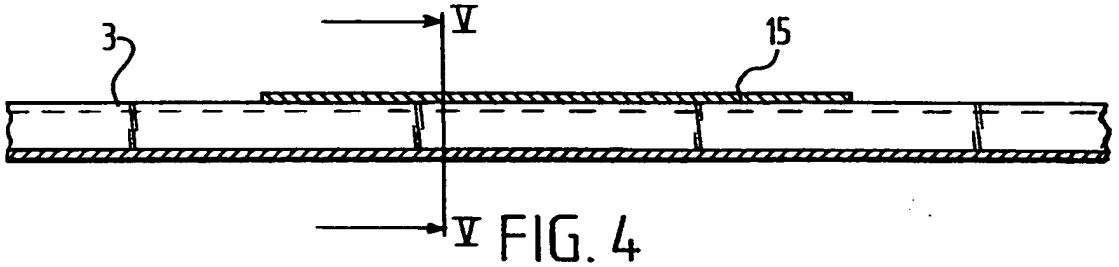

FIG. 4

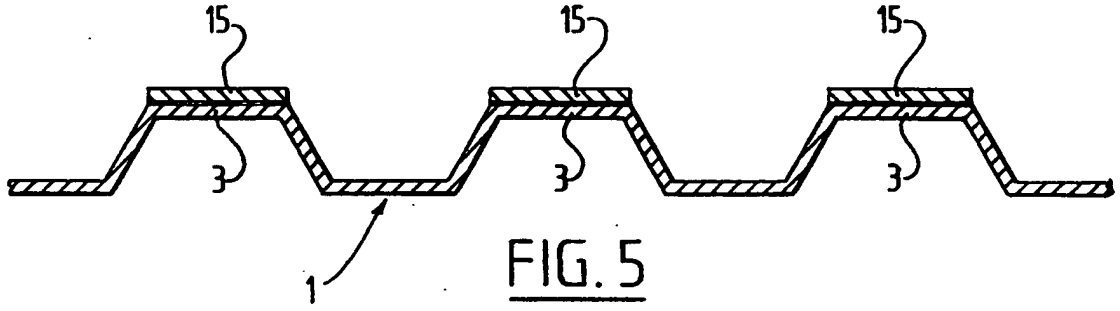

FIG. 5

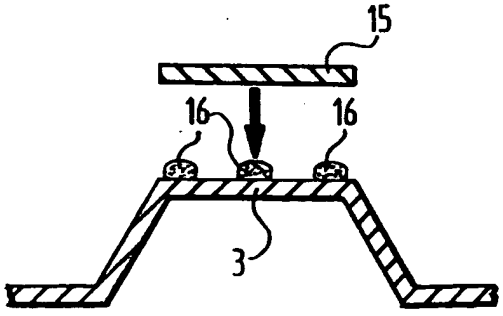

FIG. 6

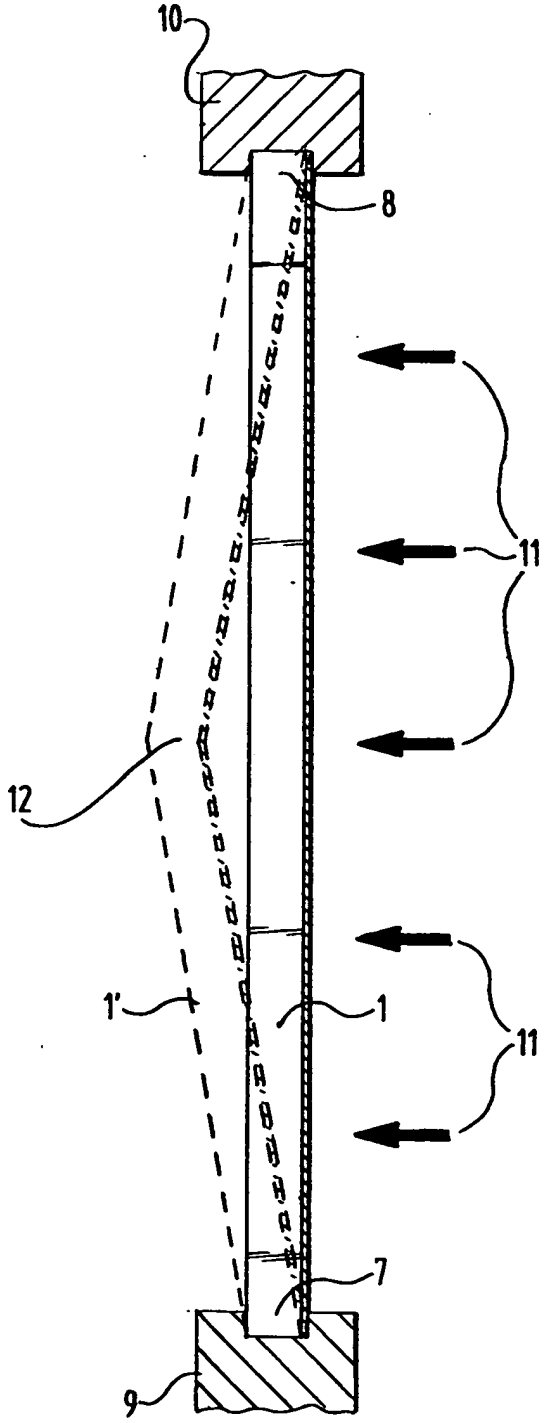

FIG.2

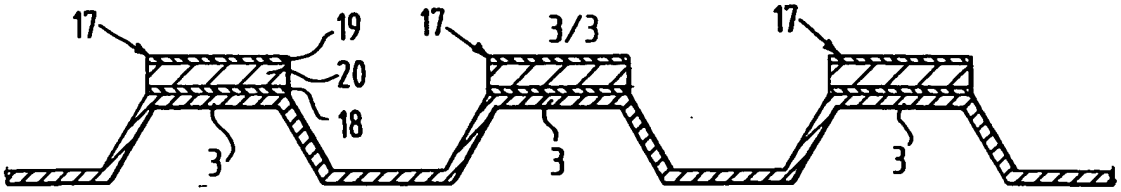

FIG. 7

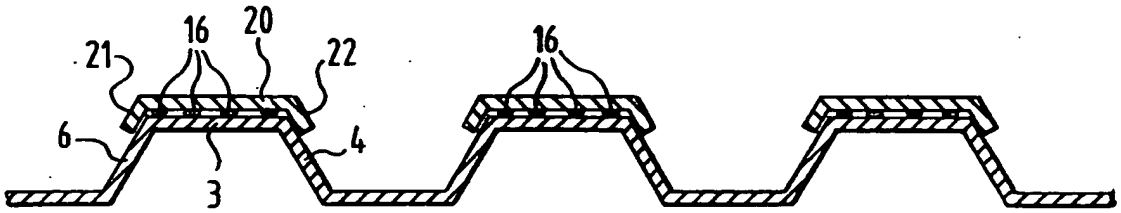

FIG. 8

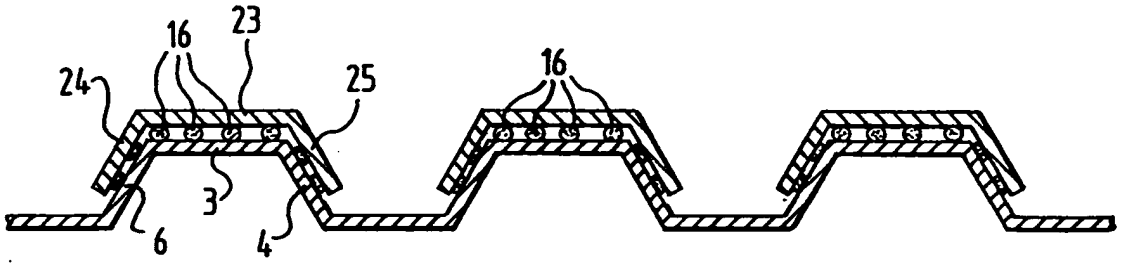

FIG. 9

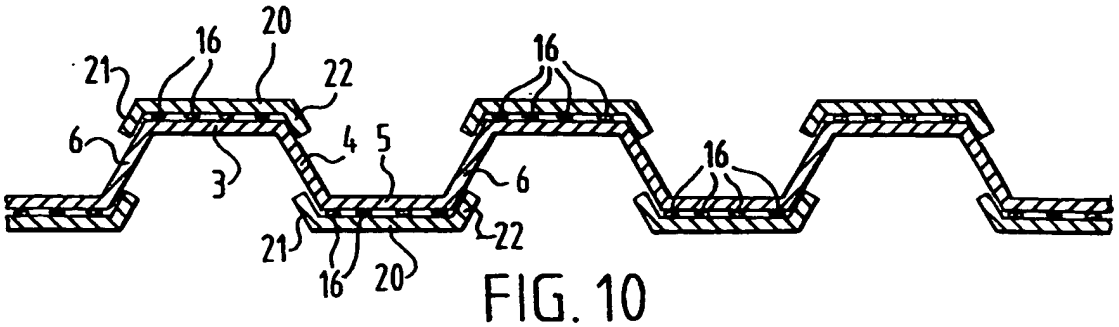

FIG. 10

INTERNATIONAL SEARCH REPORT

Ir ational Application No
PCT/NL 98/00118

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E04C2/32 E04B1/98

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E04C E04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 472 473 A (DAVIS ET AL.) 18 September 1984 see column 2, line 59 - column 4, line 3; figures 1-8	1-4,6-8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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4 June 1998	12/06/1998

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4472473 A	18-09-1984	NONE	